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"TINY TRAN" - A MINIATURE RIG FOR 10 AND 11 METERS

ALL BAND FREQUENCY MULTIPLIER IS GANGED TUNED FOR RAPID QSY

By
GEORGE D. HANCHETT, JR., W2YM
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The increasing popularity of 80-meter VFO's has stimulated the need for a companion unit, a frequency multiplier, which can be used with the VFO to operate on all the lower frequency bands: 80, 40, 20, 15, and 10-11 meters. Such a unit, designed to work with the VFO described in the last issue of HAM TIPS,† is the subject of this article. Its design, in addition to providing the usual desirable qualities of simplicity and compactness, features good shielding for a minimum of TVI.

Because the multiplier requires only one ganged tuning control, shifting from one band to another is a very simple operation. Although a preliminary design of this multiplier employed broad-band tuned circuits in order to eliminate the one tuning control, tests indicated that the broad-tuned arrangement was more likely to cause TVI than the ganged-tuned circuit.

The circuit itself is conventional. Four stages are used; a 7-megacycle doubler, a 14-megacycle doubler, a 28- megacycle doubler, and a 21-megacycle tripler.

Construction Details

An aluminum chassis 3" x 4" x 17" is used for the multiplier. All the components with the exception of the tubes and heater transformer are mounted inside the chassis. An aluminum panel, 5¼ inches wide, covers the open side of the chassis and serves as the front panel. The metal type RCA-6L6 was selected for all stages because its metal shell provides complete shielding of the tube. Another tube type could have been used with equally satisfactory results, but since it was desired to operate the multiplier from a single 350-volt supply and to obtain enough power to excite an RCA-813 as a final amplifier, the 6L6 was chosen.

The four series tracking capacitors (C_7, C_{14}, C_{21}, and C_{27}) are mounted on the top side of the chassis between the tank coils. The parallel padding capacitors (C_9, C_{19}, C_{17}, C_{23}, and C_{29}) are mounted behind each section of the ganged tuning capacitors (C_1, C_4, C_{11}, C_{21}, and C_{28}) and are available from the bottom of the chassis. The tuning control for the ganged

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FREQUENCY MULTIPLIER

Requiring only one ganged-tuning control, the all band frequency multiplier makes shifting from one band to another a simple operation. Its design provides compactness and good shielding to minimize TVI.

MOBILE TRANSMITTER DESIGNED AROUND NEW RCA-5763 PENTODE

By
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Being avid mobile fans, originally by necessity, later by choice, the possibilities envisioned in the recently announced rf power pentode, the RCA-5763, were intriguing. The result was "Tiny-Tran", a miniature mobile transmitter for 10 and 11 meters. This 5 x 9½ x 2½ inch rig operates with a plate input power to the final of 15 watts at 27 to 30 Mc. The heater drain is only 2.7 amperes at 6.0 volts and the plate supply 140 ma at 300 volts.

Let's take a look at the output tube first. The 5763 is a 9-pin miniature transmitting type, capable of 15 watts input up to 175 Mc. The high-perveance characteristic is particularly suitable for mobile operation because it considerably reduces power supply problems. Another important feature is the heater rating. The cathode is so constructed as to give full emission with only 6.0 volts applied to the heater. Heater voltage is an important consideration in mobile work since, more often than not, the battery voltage less the line drop approximates this 6-volt figure.

Quite naturally, its size, too, is interesting, since the 5763 is only slightly larger in diameter than the 7-pin miniature 6AQ5. When the 5763 is used in the rf stages, and other miniatures are used in the audio stages, economy of space is at a maximum.

The heater requirements and maximum ratings of the RCA-5763 are as follows:

Heater Voltage (ac or dc)	6.0 ± 10% volts
Heater Current	0.75 ampere
DC Plate Voltage	300 max. volts
DC Grid-No. 3 (Suppressor) Voltage	0 max. volts
DC Grid-No. 2 (Screen) Voltage	250 max. volts
DC Grid-No. 1 (Control-Grid) Voltage	125 max. volts
DC Plate Current	50 max. ma
DC Grid-No. 2 Current	15 max. ma
DC Grid-No. 1 Current	5 max. ma
Plate Input	15 max. watts
Grid-No. 2 Input	2 max. watts
Plate Dissipation	12 max. watts

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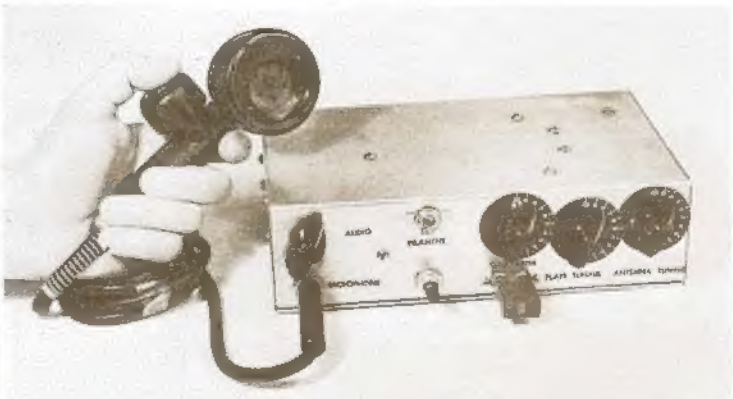
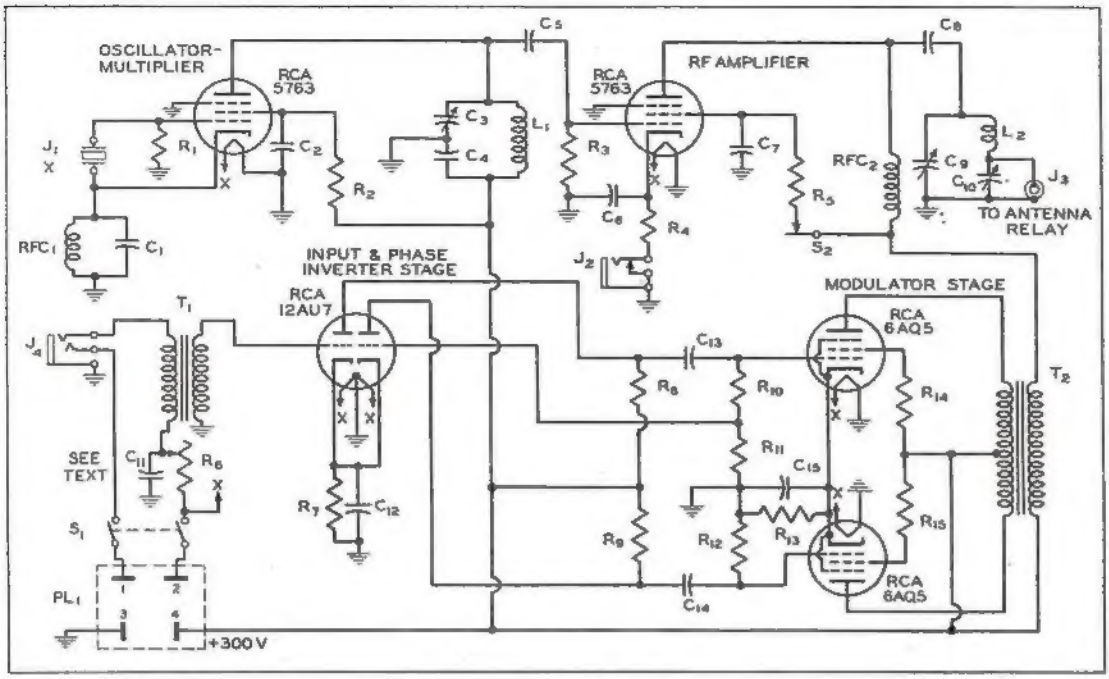
THE "TINY-TRAN"



Completely housed in a 5" x 9½" x 2½" chassis, this miniature transmitter is particularly suited for mobile work. It uses the new RCA-5763 rf power pentode as an output tube, and operates with a plate input power to the final of 15 watts at 27 to 30 Mc.



Schematic of the "Tiny-Tran"

"TINY TRAN"

(Continued from Page 1, Column 4)

Design Considerations

Because mobile operation can take place anywhere, it seemed advisable to design a unit readily adaptable to a Crosley or a Cadillac, a Piper Cub or a DC-6, a rowboat or the Queen Mary. By employing miniature tubes and small components, it was possible to place the entire circuit *inside* a small metal chassis 5 x 9½ x 2½ inches. This size and shape lends itself readily to mounting in any number of positions about the panel of a car. Even the glove compartment of most models will accommodate such a box. All controls are brought to the front panel with the exception of the meter jack, which is brought out in the rear.

The bottom plate of the chassis becomes the side panel, and gives access to the "innards" of the rig by removal of the self-tapping screws. Two sub panels are cut to fit as indicated in the photographs. The lower panel holds the audio stages, while the upper one supports the rf unit. Some of the components are mounted directly on the chassis, but, despite cramped quarters, all parts and wiring are quite accessible.

Because the 5763 is designed to operate at a high temperature (maximum 250° C) and requires good ventilation, a series of holes is drilled in the top of the case and in the cover plate directly opposite the tubes. A similar arrangement is also made for cooling the modulator stage.

RF Section

The rf section utilizes two of the new RCA-5763's, one as tritet oscillator-multiplier, and the other as an rf final amplifier. When a crystal in the order of 7 Mc is used, ample drive to the grid of the final at 28 Mc is obtained readily.

An important space-saving feature is the tritet coil which is a commercial rf choke, the size of a one-watt resistor. The inductance and Q requirements of this coil are met very satisfactorily by the Ohmite Choke, Z144.

The antenna coupling system is especially interesting because it very effectively discriminates against harmonics. (1) This type of coupling (a modified pi network) compared to the conventional link coupling, provides only ¼ of the 2nd-harmonic output, 1/9 of the 3rd-harmonic output, and proportionately smaller amounts of higher-order harmonics. Maximum loading is obtained by tuning the capacitors in the pi network. In one particular installation of this "Tiny-Tran", the antenna was fed with a 2-foot length of 72-ohm coax line. Placement of the transmitter in the front area of the car, incidentally, allows use of a standard 4-section collapsible receiving antenna capable of being extended to 100 inches or more. This position eliminates the need for drilling holes in the rear deck of the car for the more costly police-type whips.

Audio Section

The audio section is also simple in design. An RCA 12AU7 medium-mu twin triode is used as the input phase-inverter stage, and is coupled by means of capacitors to a pair of 6AQ5's which function as class AB modulators. All operating conditions are carefully chosen so that clean, crisp speech results. This tube line-up, as in the rf section, allows either a parallel or series-parallel heater connection for 6-or 12-volt battery operation. (Most personal aircraft and some small cars use 12-volt electrical systems).

The miniature components given in the parts list are the ones used in this transmitter. Substitutions may be made if they are equivalent in size as well as electrical characteristics.

The antenna transfer relay is mounted at the base of the antenna and is controlled by the circuit that operates the dynamotor relay. Thus, when the microphone push-to-talk switch is pressed, the dynamotor is started, the antenna transferred, and voltage applied to the mike button.

Construction

The chassis, the two shelves, and the cover plate are first drilled and shaped. Next the shelves and major components are mounted inside the chassis to check their fit. The only component which requires any change in adjustments to insure a proper fit is the modulation transformer. Its rear mounting ear is bent down even with the side of the transformer shell, thus making the unit fit snugly against the rear wall of the chassis to which the transformer is bolted.

After all components fit satisfactorily, the rf and modulator shelves are removed and wiring of the transmitter started. The two shelves should be wired as completely as possible before mounting them inside the chassis. Leads leaving the shelves for connection to other components should be left sufficiently long for easy connection. The rf shelf, which contains the 5763 oscillator at the left and the 5763 amplifier at the right, should be mounted in the chassis first. Wiring for the rf section of the transmitter can then be completed. The hot heater supply lead for this section goes directly up from the main switch, S_1. The B+ supply lead goes to a 2-terminal lug strip mounted below the shelf on the mounting screw of an rf amplifier socket. The B+ end of RFC_2 is secured to a 1-terminal lug strip mounted to the right of the rf amplifier tube above the shelf. This lead is covered with a varnished cambric tubing and passed through a small hole in the rf shelf in such a manner as to bring the plate lead directly away from the grid connection. The B+ end of L_1 is also connected to a 1-terminal lug strip. All leads are kept short and a common ground point is used for each stage.

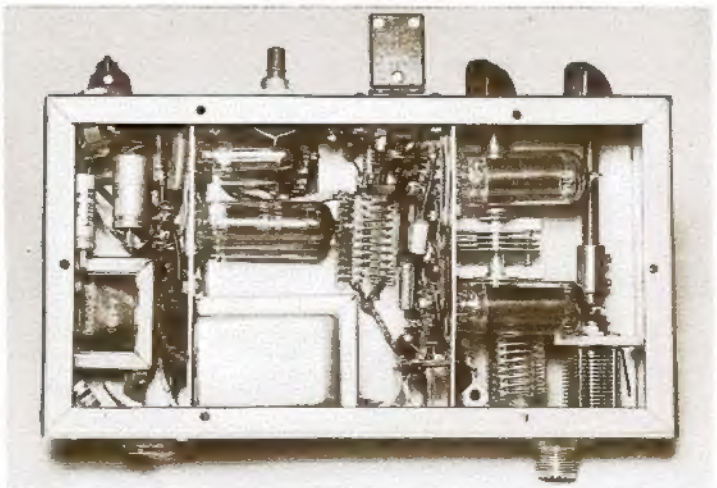
Checking The RF Section

It is suggested that the rf section be tested before mounting the audio shelf in the chassis.

For preliminary testing in the ham shack a half-wave dipole cut to frequency and center fed with a section of 72-ohm coax approximately equal in length to that used in the mobile installation should be used. Crystals between 7.125 Mc and 7.425 Mc should be used for 10-meter phone and between 6.79 Mc and 6.857 Mc for 11 meters. In-

(Continued on Page 3, Column 2)

A REAL HANDFUL



An inside view of the miniature transmitter reveals two sub panels and the manner in which parts are positioned and wired. Despite cramped quarters, all components are fairly accessible.

FREQUENCY MULTIPLIER

(Continued from Page 1, Column 2)

tuning capacitors is brought out to the front panel by means of a Millen right-angle drive shaft. The band selector switch and the on-off switch are also located on the front panel.

In order that an adjustment of the output power can be made by means of a potentiometer or rheostat on the power supply chassis or in some other convenient place, the B-supply lead to the screen grids of the 6L6's is brought out to a separate terminal on the power terminal strip. The ground connection for each stage is made at a common point for the stage and consists of a large soldering lug clamped under one of the socket mounting bolts. RF chokes RFC_1, RFC_2, RFC_3, and RFC_4, together with capacitors C_{20}, C_{21}, C_{22}, and C_{23}, are used as lead filters for the power supply to reduce the harmonic voltage on the power cable. These filters are not necessary in areas where TVI is not a problem. The circuit is designed with cathode bias so that either VFO or crystal keying may be used. No meter connections are provided because it is practical to use the grid current in the first stage of the following unit for tuning purposes.

Alignment Procedure

The alignment of the unit is relatively simple and can be accomplished in less than three minutes. The chief reason for the ease and simplicity of alignment is that adjustments are made by means of the series and parallel padding and tracking capacitors rather than by the tedious and laborious tapping of coils.

The multiplier is aligned in the following manner after the wiring has been completed but before the panel is assembled. The first stage to be aligned is the input circuit which is tuned to cover 3.4 megacycles to approximately 3.75 megacycles. First, connect the VFO to the multiplier and set the output

(Continued on Page 4, Column 1)

"TINY TRAN"

(Continued from Page 2, Column 4)

sert a 0-100 ma meter in the cathode circuit (J2) of the final amplifier, open switch S2, and tune the oscillator circuit for resonance by adjusting capacitor C_9 for the meter reading. This reading indicates grid current of the final amplifier because S2 interrupts the screen supply of the final and allows no plate or screen current to flow. When sufficient grid drive is obtained (3 to 5 ma), the rf amplifier can be operated by releasing S_2 and tuning C_9 in final tank for a dip in the cathode current. The oscillator tube draws approximately 35 ma at 300 volts.

Loading

The antenna should be cut reasonably close to the correct length for the operating frequency to prevent any difficulty in loading the transmitter. Decreasing the capacitance of C_{10} increases the plate loading but, for efficient transfer of power to the antenna, the capacitive reactance of C_{10} should equal the transmission-line impedance. For 72-ohm coax, C_{10} should be adjusted to approximately 80 $\mu\mu$f and for 52-ohm coax, to about 100 $\mu\mu$f. If this adjustment does not provide a plate current of 45 to 50 ma (measured cathode current less 8 ma screen current and 3-to 5-ma control-grid current), decrease the capacitance of C_{10} until the proper value is obtained. After each change in C_{10}, retune C_9 for maximum dip in cathode current. A further check may be made by means of a neon bulb placed at the ends of the antenna.

Adding Modulator Section

After checking out the rf portion of the transmitter, the modulator is completed. Leads on transformer T_1 are left sufficiently long so that the transformer may be fastened to the chassis after the bottom shelf is mounted. The leads to the secondary of the modulation transformer are connected for a plate-to-plate load impedance of 4500 ohms, determined by the chart accompanying the transformer.

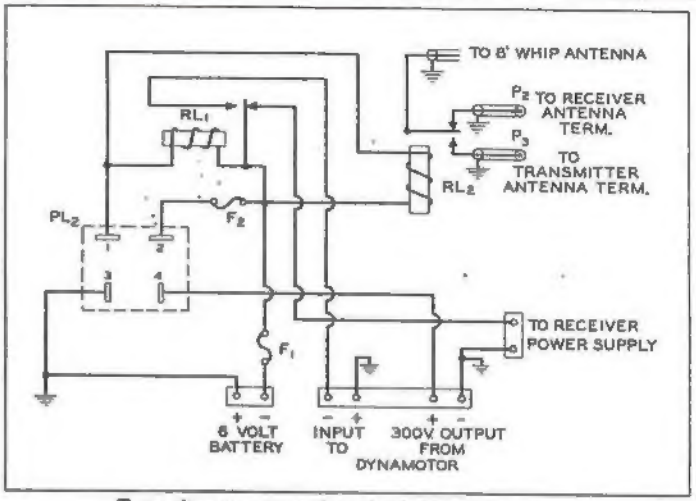
The 1000-ohm potentiometer which controls the microphone current must be insulated from the chassis because this miniature style pot is obtainable only with the rotor grounded. The proper connection of C_{11} should be determined before it is installed because its polarity must correspond to the polarity of the car battery. The connections shown in the schematic is for cars having the positive battery terminal grounded.

Checking The Modulator

It is a good idea to test the modulator thoroughly before mounting it in the chassis. The best check is to complete the wiring of the transmitter and operate it in the phone band with a temporary antenna. The 3 tubes in the modulator should draw approximately 48 ma at 300 volts. If ac is used for heater power during the test, use a 6-volt battery for energizing the microphone. Modulation can be checked on a scope by conventional methods or on a good phone monitor. The microphone used with this transmitter is a surplus T-17 single-button carbon unit. The bakelite face plate should be removed and 5 or 6 additional holes drilled in it. These additional air paths increase the output of the T-17 substantially, because its basic design is for close-talking service and low extraneous pickup.

The leads connected to S_1 are passed through the grommet in the lower shelf and then through the grommet in the back of the chassis. Then, the lower shelf is positioned diagonally in the chassis with the modulation transformer against the rf shelf and the left end of the shelf above R_8. Next, the modulator transformer is pushed down and the shelf fastened in position. T_2, C_{11}, and J_3 are then fastened in position.

The many enjoyable contacts this transmitter has provided, its handy compactness, and its excellent signal quality make it a very worthwhile spring project for a summer-vacation time of QSO's on 10 and 11.



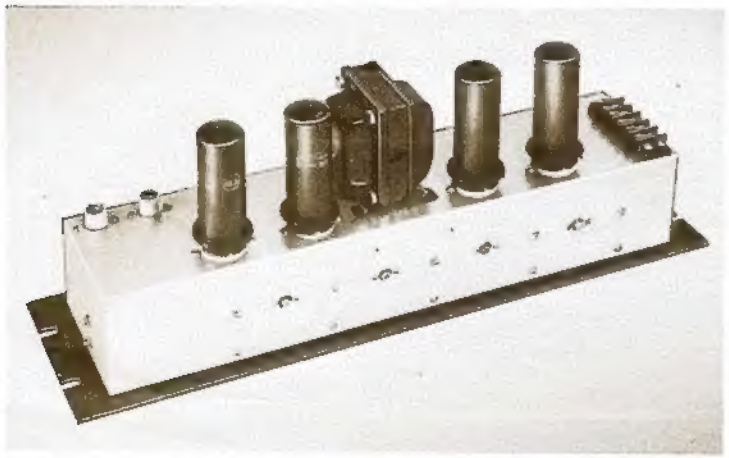
Transmitter power supply and switching arrangement.

(1) Terman-Radio Engineers Handbook, Section 9-3, "Suppression of Harmonic Radiation".

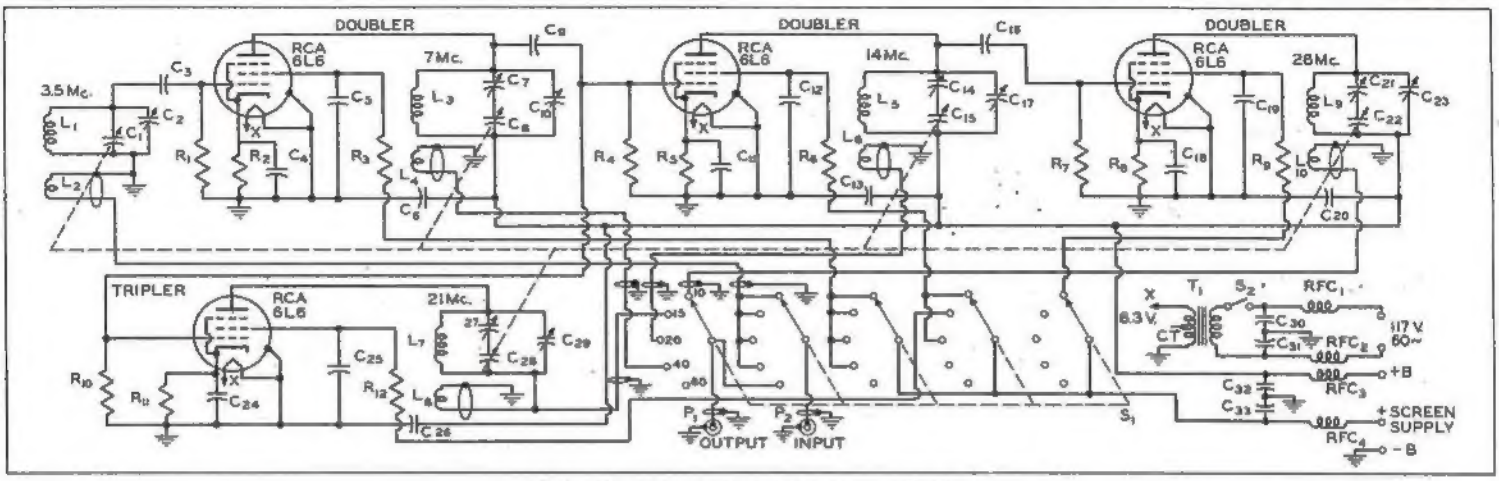
PARTS LIST

C_1	0.00015 uf, 500 V, Aerovox #1468, Mica
$C_{2,4,6,7,8}$	0.001 uf, 500 V, Aerovox #1468, Mica
C_3	25 uuf, Variable, Millen #20025
C_5	50 uuf, Eric Ceramicon #V393-139
C_9	50 uuf, Variable, Millen #19050
C_{10}	100 uuf, Variable, Hammarlund HF-100
C_{11}	50 uf, 6V, Elretrolytic, Cornell Dubilier BBR 50-6
C_{12}	10 uf, 25V, Electrolytic, Cornell Dubilier BBR 10-25
$C_{13,14}$	0.01 uf, 400V, Paper, Cornell Dubilier ZNW1S1
C_{15}	20 uf, 25V, Electrolytic, Cornell Dubilier BBR 20-25
J_1	Crystal socket, 0.487" spacing, Millen 33102
J_2	Closed-circuit Jack, Mallory #A-2
J_3	Coax Connector, Chassis Type, Amphenol 83-1R
J_4	Microphone Jack, 3 circuit, Mallory #SCA-2B
$L_{1,2}$	10 turns, 3/4" Dia., 1 3/4" Long, B&W #3010
PL_1	4-contact male plug, Jones #P-404-CCT
PL_2	4-contact female socket, Jones #S-404-CCT
RFC_1	1.8 uh, RF Choke, Ohmite #Z-144
RFC_2	21, uh, RF Choke, Ohmite #Z-28
RL_1	6-V, SPDT Relay, 15A Contacts
RL_2	6-V, SPDT Antenna Relay
$R_{1,8,9}$	100,000 ohms, 1/2 W, Carbon, Ohmite Little Devil
$R_{3,5}$	6,800 ohms, 2 W, Carbon, Ohmite Little Devil
R_2	20,000 ohms, 1 W, Carbon, Ohmite Little Devil
R_4	68 ohms, 1/2 W, Carbon, Ohmite Little Devil
R_6	1,000 ohms, Pot, Mallory C1MP
R_7	3,300 ohms, 1/2 W, Carbon, Ohmite Little Devil
$R_{10,11}$	200,000 ohms, 1/2 W, Carbon, Ohmite Little Devil
R_{11}	15,000 ohms, 1/2 W, Carbon, Ohmite Little Devil
R_{12}	390 ohms, 2 W, Carbon, Ohmite Little Devil
$R_{14,15}$	33,000 ohms, 1 W, Carbon, Ohmite Little Devil
S_1	DPST, Toggle Switch, C-H, #8360, with bat handle
S_2	Momentary Push Switch, Norm Closed, Centralab #1470
T_1	Microphone Transformer—Stancor A4706
T_2	Modulation Transformer—10 W, Thordarson T-21M52

BEHIND-THE-PANEL VIEW



The frequency multiplier is mounted on a 3" x 4" x 17" aluminum chassis. Metal type 6L6 tubes are used in all stages for effective shielding. All components with the exception of the tubes and heater transformer are mounted inside the chassis.



Schematic of the gang-tuned frequency multiplier.

FREQUENCY MULTIPLIER

Continued from Page 3, Column 1

of the VFO to 3.4 megacycles. When the multiplier band switch is in the 3.5-megacycles (80-meter) position, output power is available at the coaxial output connector (P_1). Next, turn the band switch to the 7-megacycle (40-meter) position and apply heater voltage to the multiplier tubes. Connect a vacuum-tube voltmeter such as the VoltOhmyst* Electronic Meter WV-195-A to the grid terminal of the first (7-megacycle) doubler stage. Before the plate voltage is applied, set the ganged tuning capacitors for maximum capacitance and adjust the parallel padding capacitor C_2 so that the input tank circuit is resonant. Resonance is indicated by maximum meter reading. If a low-range milliammeter is used, it should be connected in series with the grid resistor on the ground side. The excitation from the VFO should be increased until the voltmeter reads approximately 100 volts. If a milliammeter is used, the current should be approximately 3 ma. Now, turn the ganged tuning capacitors to the position of minimum capacitance and then reset the VFO frequency for maximum grid voltage. The frequency of the VFO should be slightly above 3.75 megacycles.

In the alignment of all stages, the meter should be placed either across the grid resistor of the stage following the one being aligned or else across the cathode resistor of the stage being aligned. To adjust the 7-megacycle doubler stage, leave the VFO at 3.75 megacycles and the ganged tuning capacitor at minimum capacitance, and apply voltage to the plates and screens. As soon as this voltage is applied, adjust the parallel padding capacitor C_{28} for resonance without delay. It is necessary to make this adjustment as quickly as possible because the out-of-resonance plate current may be excessive and damage the tube. The cathode current is approximately 25 ma; the cathode voltage as measured with the VoltOhmyst Electronic Meter is approximately 14 volts.

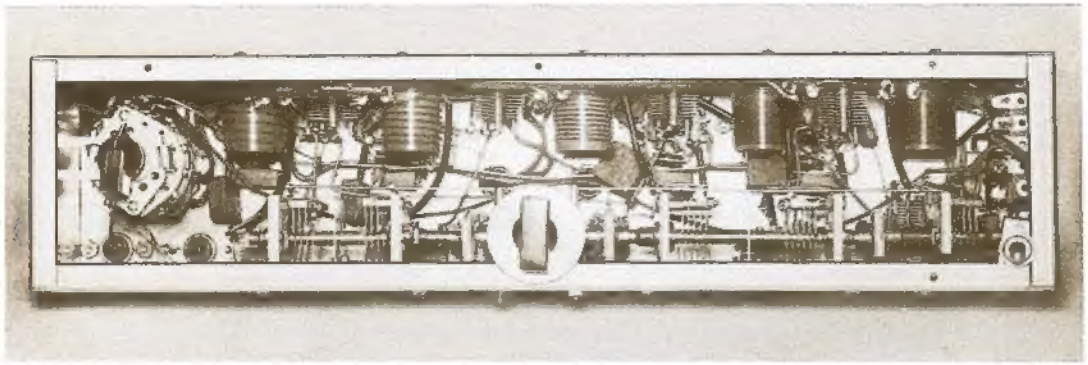
To complete the adjustment of the 7-megacycle doubler stage, tune the VFO to 3.4 megacycles and set the ganged tuning capacitor for maximum capacitance. Then, adjust the series padding capacitor (C_7) for maximum voltage across the grid resistor (R_4) of the 14-megacycle doubler stage. Return the VFO to 3.75 megacycles and adjust the parallel padding capacitor C_{17} to restore resonance. Only a slight change should be necessary.

All the other multiplier stages are aligned in exactly the same manner. The cathode current of the stage being used to excite the driver or final may be increased to as much as 60 or 70 ma. Cathode currents of all other stages will run approximately 25 ma per stage. For direct excitation of a final 813 power amplifier, a cathode current of 50 ma for the driving stage was found to be more than sufficient.

†"Self-contained VFO Designed for Stability on All Bands", by Andrew Rau, Jr., W3KBZ, (Ham Tips, Jan. Feb. 1949)

*Registered Trade Mark, U.S. Pat. Office

INTERIOR VIEW OF MULTIPLIER



Well planned design of the frequency multiplier reveals simplicity of construction and the compact manner in which wiring and components are placed. The tuning control for the ganged tuning capacitors is brought out to the front panel by a right-angle drive shaft, shown in center of photo.

PARTS LIST

C_1	25 uuf, variable, Cardwell ZR-25-AS
C_2	100 uuf, variable (APC-100)
C_3	47 uuf, 500 V, mica
C_4, C_{11}, C_{15} C_{24}	.01 uf, 300 V, mica
C_5, C_{12}, C_{19} C_{25}	0.006 uf, 500 V, mica
C_6, C_{13}, C_{26} C_{29}, C_{30}, C_{31}, C_{32}, C_{33}	0.003 uf, 500 V, mica
C_7	75 uuf, variable (APC-75)
C_8, C_{16}	35 uuf, variable, one section of Cardwell ER-35-AD
C_9 C_{10}, C_{14}, C_{21}	22 uuf, 500 V, mica
C_{27}	50 uuf, variable (APC-50)
C_{18}	15 uuf, 500 V, mica
C_{17}, C_{22}, C_{23}	25 uuf, variable (APC-25)
C_{28}, C_{34}	25 uuf, variable, one section of Cardwell ER-25-AD
R_1, R_4, R_7 R_{10}	33,000 ohms, 1 watt, carbon
R_2, R_5, R_8 R_{11}	560 ohms, 1 watt, carbon
R_3, R_6, R_9, R_{12}	15,000 ohms, 2 watts, carbon
S_1	6 pole, 3 wafer, 6 position switch
S_2	SPST, 3 amp toggle switch
T_1	Heater transformer, 4.0 amps at 6.3 V
P_1, P_2	Coax male chassis connectors
RFC_1, RFC_2, RFC_3, RFC_4	#24 Enamelled wire, wound on 100,000 ohms, 2 watts, carbon resistor
L_1	35 turns #22e, wound 1" on National XR-2 form
L_2	21 turns #20e, wound 1" on National XR-2 form
L_3	13 turns #20e, wound 1" on National XR-2 form
L_4	8 turns #20e, wound 1" on National XR-2 form
L_5	6 turns #20e, wound 1" on National XR-2 form
L_6, L_7, L_8, L_9, L_{10}	2 turns #18e, wound close to cold end of tank coils

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